Typical PhD Screening Exam Topics: Signal Processing

Analog to digital conversion: sampling, quantization, and encoding.

Discrete signals and systems, unit sample response, and frequency response.

Bilateral z-transforms and analysis of LTI systems in the z-domain.

Discrete Fourier transform: definition, properties, linear filtering methods and frequency analysis of signals using DFT; applications of FFT algorithm for efficient computation of DFT and linear filtering; convolution and correlation, principles and implementation.

Finite impulse response filters: linear phase and zero-phase filters. Design of linear phase FIR filters (windows, frequency-sampling, and optimum equi-ripple methods) and their comparison.

Infinite impulse response filters: Butterworth, Chebychev, and elliptic (analog) filter design. IIR filter design by bilinear transformation. Frequency transformations.

Errors due to rounding and truncation: quantization of filter coefficients; round-off errors in digital filters.

Multirate signal processing: decimation and interpolation; sampling rate conversion by a rational factor, an arbitrary factor, and by multistage implementation; sampling rate conversion of bandpass signals.

Random variables: probability mass function, probability density function, and cumulative distribution function.

Random vectors: joint density and distribution functions, correlation matrix, and linear transformation of random vectors.

Random processes: random signals and sequences; simple discrete random processes; Markov processes; continuous and discrete Gaussian random processes.

Second moment analysis: correlation and covariance functions and matrices; power spectral density function; discrete Karhunen-Leove transform; white noise.

Response of LTI systems to random inputs: time and frequency-domain representation of LTI system response, spectral factorization; matched filtering.

Parameter estimation: Bayes, maximum a posteriori, maximum likelihood, and linear mean square estimation.

Note: This list is provided only as a guideline to the student and may not be completely comprehensive. Examiners reserve the right to determine specific areas of concentration, and students may be examined on any topic that broadly relates to the area.

The orthogonality principle, predictive filtering and optimal filtering (FIR and IIR).

Linear prediction. The auto-regressive (AR) model. Levinson-Durbin recursion. AR modeling using linear prediction. Linear predictive coding of waveforms.

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